Se, 10/687,818

PATENT SPECIFICATION

(11) 1 525 947

1 525 947

(21) Application No. 43745/75 (22) Filed 24 Oct. 1975
(31) Convention Application No. 7413977
(32) Filed 7 Nov. 1974
(31) Convention Application No. 7511723
(32) Filed 20 Oct. 1975 in
(33) Sweden (SE)
(44) Complete Specification published 27 Sept. 1978
(51) INT CL² B01D 33/02//33/10
(52) Index at acceptance
B1D 132 154 163 205 209 212 227 231 233 310 332 334 336 338 353 372 375 381 384 385 386 402 500 520 544 546 605 625 702 709 711 714 716 721 757 762 801 886

(19) THE PATENT OFFICE LONDON

(72) Inventors SVEN-OLOF SANDBERG and FREY VIKING SUNDMAN

(54) A METHOD AND AN APPARATUS FOR RECOVERING FIBRES FROM FIBROUS MATERIAL

(71) We, MUNKSJÖ AKTIEBOLAG, of Barnapsgaten 39, S-552 56 Jönköping, Sweden, a company organized under the laws of Sweden, and A. AHLSTRÖM OSAKEYHTIÖ, of Box 329, SF-00101 Helsingfors 10, Finland, a company organized under the laws of Finland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention concerns a method of recovering fibres from fibrous materials such as waste paper, peat and bagasse, and an apparatus are particularly intended to handle unsorted fibrous materials containing foreign matter such as e.g. waste paper and returns containing plastics-coated wrapping material.

According to a first aspect of the present invention there is provided a method of recovering fibres from fibrous material, comprising introducing said fibrous material into a rotating drum from which tearing and cutting members are absent, disintegrating the fibrous material in wet condition by setting said fibrous material into repeated alternating upwards and downwards motion inside said drum with the aid of lifting means so as to divide said fibrous material into a fine fraction and a coarse fraction, and draining off said fine fraction through apertures formed in the jacket of said drum and removing said coarse fraction through an opening formed in one end wall of said drum, the interior of the drum being substantially unobstructed to enable material lifted by the lifting means to fall freely from the top region to the bottom region of the drum.

According to a second aspect of the present invention there is provided apparatus for recovery of fibres from a fibrous material by defibrating said fibrous material in a liquid, said apparatus comprising a rotatably mounted drum with an opening in one end wall thereof and an apertured jacket surface, ribs provided inside said drum so as to extend essentially in the longitudinal direction of said drum, said ribs serving in use as lifting means setting said fibrous material in motion inside said drum upon rotation thereof, said drum having absent therefrom tearing and cutting members, and tube conduit means for supplying defibrating liquid into said drum, the interior of the drum being substantially unobstructed to enable material lifted by lifting means to fall freely from the top region to the bottom region of the drum.

Upon rotation of the drum the material fed thereinto takes part in the drum rotation and is lifted by the drum ribs to a level above the drum centre axis from which level the material falls down to the lowest point of the drum jacket. By choosing a rotational speed of the drum appropriate to the drum diameter it is possible to bring the material along to a position close to the highest point of the drum. Liquid necessary for the defibration of the cellulose material is supplied continuously to the drum interior and surplus liquid is drained off through the perforations made in the drum jacket. When the cellulose material has been fed into the drum it is first submitted to a wetting phase. When the cellulose material, soaked through, falls down and impinges against the lower part of the drum jacket the fibre bonds are destroyed but other matter may remain intact. Detached fibres

and fibre clusters which may pass through the perforations in the drum jacket are drained off therethrough together with the defibration liquid, down into a tank positioned below the drum.

The mounting consumption of paper has increased the need for re-use of waste paper and returns as the raw material in the manufacture of paper and cardboard materials. One of the difficulties in making use of this raw material is its heterogeneous condition. Unsorted waste paper may contain paper having a high wet strength, paper that may only be disintegrated with great difficulty, foils, metal strings, threads and other particles that have to be removed. In connection with the collection of waste paper foreign matter may be separated but some of the foreign matter and pollutants may be separated only in connection with the disintegration and defibration of the waste paper or during a later stage of the treatment.

To disintegrate and defriate waste paper a pulper has hitherto been used, i.e. an apparatus consisting of a trough wherein a winged rotating impeller wheel sets into motion the liquid wherein the defibration takes place. The waste paper is defibrated in a pulper in the following manner:

owing to the effect of the suction created by the impeller wheel the material flows towards the impeller wheel centre. When the material moves towards the wheel periphery, it is exposed to impacts from the wings of the rotating impeller wheel and thus is shredded into pieces.

The paper pieces are thrown away from the impeller wheel at a high speed. As a result of the difference in speed between the material thrown away from the impeller wheel and the environmental medium the paper pieces are exposed to frictional forces which detach the fibres.

To achieve complete defibration in a pulper operating in accordance with the principle outlined above, it is necessary to expose the waste paper to a lengthy treatment. Disintegration usually is carried out at a solids concentration of 2—3% by weight, for which reason the amount of liquid circulating inside the pulper is considerable and the required power consequently high. Usually, the defibration therefore cannot be completed with the aid of the pulper but may be carried out only to a degree which is sufficient to obtain a pumpable pulp which is led to the disintegrator in which the defibration is completed.

The method hitherto used to disintegrate waste paper, i.e. with the aid of a pulper, suffers from certain disadvantages. When treating unsorted waste paper containing e.g. plastics-coated paper, the flow of material fed to the disintegrator will contain pieces of paper which are not completely disintegrated and from which the plastics material has not been removed. The plastics material is shredded into small pieces in the disintegrator and these pieces are difficult to remove from the system in subsequent stages of the process. The waste paper is exposed to tearing effects in the pulper, whereby the fibres are destroyed. In a pulper which works in a continuous manner, it is difficult to remove all foreign matter separated therein. The screen of the pulper is provided with comparatively large openings, in the order of between 6 and 25 millimetres, and consequently paper clips and other metal objects may pass through.

In accordance with the method of the present invention the waste paper is defibrated in a manner permitting separation of coarse matter before the fibrous material is led to a disintegrator for further defibration. As a result, it becomes possible, without previous sorting, to make use of waste paper, containing e.g. plastics-coated wrapping and packaging materials.

The invention may be carried out either continuously or in batches.

Peat collected from bogs, contains between 85 and 95% by weight of water as well as stones, roots and root parts. To convert peat to pumpable form it has hitherto been customary to dissolve it in a pulper, wherein it is diluted into a suspension the dry contents of which are less than 5% by weight, whereafter the suspension is later dewatered. As it is difficult to dewater peat, it is desirable that water is added in amounts as small as possible. In order that the rotor of the pulper does not break, the peat must be subjected to coarse (primary) sorting before its disintegration. One has found that the disintegration of wet peat and the separation of the dry substance from the coarse particles may be performed with extreme efficiency and without subjecting the peat to a primary sorting, if it is treated in a rotating, perforated drum. If the peat dry contents exceed 10% by weight, liquid is added to dilute it. During the treatment in the drum, the solid structure of the peat is disintegrated, and the detached peat is drawn off through the apertures in the drum jacket, whereas stones, roots and root parts remain and may be removed at the drum end. A pumpable pulp thus is obtained the dry contents of which amount to 10% by weight.

Bagasse which is obtained as a residue product after extraction and pressing-out of the sugar contents from sugar canes may also be used to produce cellulose. Bagasse contains about two thirds of fibres (as calculated on the dry substance) which are

suitable for use in the cellulose manufacture, and about one third of pith cells which are suitable for this purpose. To remove the pith cells which are present mainly in the sugar cane stem centre, the bagasse has hitherto been treated in machines that requires considerable amounts of energy, such as hammer mills or pulpers. On has found, however, that the separation of the cellulose cells from the pith cells may be carried out with surprising ease in a rotating drum having a perforated jacket. The pith cells which are short are flushed through the drum apertures together with the water, and the cellulose fibres may be removed in the shape of sticks at the drum end. In the drum, the epidermis cells which form a waxy surface layer on the stems which is detrimental to the cellulose manufacture are likewise scraped off.

The rinsing liquid is preferably circulated and drained off when it contains between 2 and 4% by weight of pith cells, etc. The cellulose fibres are removed when they have a dry content of between 15 and 20% by weight. The bagasse preferably is cut into small lengths and crushed before its treatment in the drum.

The invention will now be described in more detail with reference to the accompanying drawings, showing apparatus according to the invention intended for continuous operation:

More precisely, Fig. 1 is a schematic representation of one embodiment of the apparatus in accordance with the invention,

Fig. 2 is a sectional view along line A—A of Fig. 1, and

Figs. 3, 4, and 5 are views illustrating the structure of a slightly modified embodiment in more detail.

In Figs. 1 and 2 the following numerals are used: the dissolving drum is designated by numeral reference 1, its end walls by numerals 2 and 3 and its jacket by numeral 4. The cellulose material is supplied by means of conveyor 5 and is allowed to slide down a chute 6 into the drum through an opening in the end wall 2. The drum is provided with longitudinally extending, internal ribs 7 which continuously feed material from the lower portion of the drum jacket to a higher level, from whence the material falls downwards through the substantially unobstructed interior of the drum. Defibration liquid, possibly having necessary chemicals added thereto, is supplied through an injection tube 8. Fibre material which has been defibrated (detached) in the drum, flows together with liquid downwards into a tank 9 from whence part of the fibrous suspension thus formed is carried back into the drum through a pipe line 10 which is connected to the injection tube 8. A portion of the liquid is pumped further to a sorter apparatus 11 wherein coarse and heavy particles are removed.

In a further disintegrator 12 a defibration operation thereafter is effected to allow fibre clusters, if any, to dissolve. The fibre suspension is washed and thickened in a filter 13, to which wash water 14 is added and from which liquid is led back to the drum via a conduit 15 and to drainage via a duct 16. The fibre material is removed from the filter, whereupon it may be further cleaned for subsequent use.

Heavy material forms a sedimentation inside the tank 9 and may be removed therefrom by means of a screw conveyor 17 disposed in the tank bottom. In the drum, the fibres are separated from foreign matter which is removed from an opening in the end wall 3.

When the cellulose material has been fed into the drum, it takes a certain time, e.g. 1 to 2 minutes, before the material has absorbed moisture and the defibration stage proper starts. For this reason it might be preferable to form the jacket section at the paper supply end of the drum continuous, i.e. non-perforated. Such a non-perforated section of the drum jacket is designated by numeral 18 in the drawings.

The defibration efficiency of the drum is dependent on the drum diameter. The larger the drum, the higher the vertical drop, resulting in an increased disintegrating effect when the cellulose material impinges on the drum surface. A suitable diameter size is 2 to 3 meters. The rotational speed of the drum is preferably between

$$25\frac{1}{\sqrt{D}} \text{ and } 30\frac{1}{\sqrt{D}}$$

revolutions per minute, wherein D represents the diameter of the drum expressed in meters, and preferably

$$28\frac{1}{\sqrt{D}}$$

in order to obtain the maximum lifting power.

Each rib 7 may be of integral construction and extend from one end of the drum to the other. Alternatively, each rib may comprise a number of sections arranged one behind the other with the offset in the circumferential direction. In the latter case, the arrangement is preferably such that the section adjacent the inlet end wall 2 leads during rotation of the drum in use. When the ribs are integral

construction they may extend parallel to the axis of the drum or at an angle relative thereto. In any event, advance of the material through the drum is assisted by slightly tilting the drum so that it declines in the direction of advance. The material may also be advanced by the pressure of water or other liquid used as the defibration liquid.

Fig. 3 is a longitudinal section through a drum arranged to treat cellulose material. Fig. 4 illustrates the drum as seen in the direction towards the supply end thereof. Fig. 5 illustrates a cross-sectional view along line B—B in Fig. 3. In Figs. 3, 4 and 5 are used partly the same numeral references as in Figs. 1 and 2. The internal ribs 7 serving as lifting means extend helically lengthwise of the drum at a pitch angle which is preferably between 2° and 10°. Because those ends of the ribs 7 closest to the end wall 2 are leading during rotation of the drum in use, the ribs 7 exert an axially directed force on the material, which force advances the material forwards in the direction towards the opposite end wall 3. The drum is supported at each end by two rotatably mounted rollers 19. The drum is driven by a motor 20 by means of a drive chain 21 and chain wheels 22 and 23. Separated, coarse material is removed by scoops 24, lifting the material from the lower portion of the drum jacket into a chute 25 positioned adjacent the opening in the end wall 3.

Example 1

7,5 kg magazine paper and smaller amounts of plastics-coated packaging material, aluminium foil, textile products, leather, capsules and book covers were placed in a closed drum having a diameter of 1 meter and a length of 0,5 meters, exhibiting on its inner face 8 internal ribs extending in the longitudinal direction of the drum and having a height of 15 centimeters. The drum jacket was perforated with apertures having a diameter of 5 millimeters, with a total aperture area of 40% of the jacket surface. The drum was driven at a rotational speed of 25 revolutions per minute. 330 litres of water to which was added 200 grams NaOH and 100 grams black liquor was circulated through the drum at a flow rate of 125 litres/minute. The liquid temperature was between 45 and 50°C. After 8 minutes the drum was opened and it was found that all magazine paper had been defibrated and drained of together with the circulating liquid. The paper of the packaging material had been defibrated but the plastics material remained inside the drum without having been shredded. The aluminium foil, the textile material and other foreign matter remained inside the drum. The book covers were partly dissolved.

Example 2

For the treatment of waste paper at a capacity of 100 tons in 24 hours, containing essentially magazine and ordinary newsprint paper the drum should have the following dimensions and technical data:—

Diameter	2.5 meters
Length	10 meters
Length of perforated section	9 meters
Aperture diameter	5 millimeters
Aperture area	20%
Frequency of rotation	15 r/min
Effect	50 kW

The fibre concentration in the tank is 2—3% by weight and after the filter it is 10—12% by weight.

The defibration liquid is to consist of water having an alkali added thereto, such as NaOH, to dissolve the binding agents of the printing ink and the coating substances, and also some surface-active addition, such as black liquor, tall soft soap or other commercially available wetting agents in order to allow water to penetrate into the paper.

The defibration operation occurs efficiently already at a comparatively low temperature, such as between 40 and 60°C.

Example 3

50 kg of peat containing 10% by weight dry contents was treated during 5 minutes in a rotating drum as in the Example 1. When the drum was opened it could be established that 0.5 kg of stones, roots and root parts remained inside the drum.

The tank beneath the drum contained the major portion of the dry contents in the form of pumpable suspension containing approximately 8% by weight of peat. No diluting liquid had been added.

Example 4

15 kg of bagasse having a dry content of 50% by weight and which had previously been pre-treated in a manner not described more in detail but during which the content of pith cells had been reduced to 25% by weight, were treated in a rotating drum in accordance with the examples described above. The treatment was carried out in two steps. In the first step, the drum was rotated for 10 minutes, during which time 300 liters of circulating water were passed through the bagasse. In the second step, the water was exchanged by an equal amount of circulating rinsing water which was

allowed to flow through the bagasse during further rotation of the drum during 5 minutes. When the drum was opened it was found that approximately 80% by weight of the dry substance remained inside the drum and that the contents of pith cells had been reduced to approximately 10% by weight, which is a very satisfactory result.

Also the use of the drum for barking of low-grade timber and twigs falls within the scope of the present invention, as does also the use thereof for the disintegration of undissolved wood-chips and separation of the knots in paper pulp after digestion.

The size of the apertures in the drum jacket should suit the desired sorting grade. Suitable sizes for waste paper, peat and bagasse are respectively 4—6, 8—15, and 3—5 millimetres.

WHAT WE CLAIM IS:—

1. A method of recovering fibres from fibrous material, comprising introducing said fibrous material into a rotating drum from which tearing and cutting members are absent, disintegrating the fibrous material in wet condition by setting said fibrous material into repeated alternating upwards and downwards motion inside said drum with the aid of lifting means so as to divide said fibrous material into a fine fraction and a coarse fraction, and draining off said fine fraction through apertures formed in the jacket of said drum and removing said coarse fraction through an opening formed in one end wall of said drum, the interior of the drum being substantially unobstructed to enable material lifted by the lifting means to fall freely from the top region to the bottom region of the drum.

2. A method according to Claim 1, wherein said fibrous material consists of waste paper from which fibres are to be removed, and defibration of the material is accomplished by using an alkaline liquid containing a surface tension reducing agent which liquid serves as a wetting agent and dissolves the binding agents of printing ink of said waste paper.

3. A method as claimed in Claim 2, wherein the liquid is made alkaline through the addition of sodium hydroxide, and black liquor is used as the surface-tension reducing agent.

4. A method as claimed in Claim 1, wherein peat having a dry content of 10% by weight or less is transformed into a pumpable suspension by being treated in the drum without additional water.

5. A method as claimed in Claim 1, wherein the pith cells are removed from the bagasse by wetting the bagasse in the drum, in a first step with the use of circulating water and in a second step with the use of rinsing water.

6. A method as claimed in any one of the preceding claims wherein a portion of the liquid containing disintegrated fibrous material is returned to the drum.

7. A method as claimed in any one of the preceding claims, wherein the fibrous material is supplied continuously into the drum and coarse material is discharged continuously from the drum.

8. A method as claimed in any one of the preceding claims, wherein the drum is driven at a rotational speed of between

$$25\frac{1}{\sqrt{D}} \text{ and } 30\frac{1}{\sqrt{D}}$$

revolutions per minute, preferably at

$$28\frac{1}{\sqrt{D}}$$

revolutions per minute, wherein D is the diameter of the drum expressed in metres.

9. Apparatus for recovery of fibres from a fibrous material by defibrating said fibrous material in a liquid, said apparatus comprising a rotatably mounted drum with an opening in one end wall thereof and an apertured jacket surface, ribs provided inside said drum so as to extend essentially in the longitudinal direction of said drum, said ribs serving in use as lifting means setting said fibrous material in motion inside said drum upon rotation thereof, said drum having absent therefrom tearing and cutting members, and tube conduit means for supplying defibrating liquid into said drum, the interior of the drum being substantially unobstructed to enable material lifted by the lifting means to fall freely from the top region to the bottom region of the drum.

10. Apparatus as claimed in Claim 9, wherein the other end wall of the drum is provided with an opening for the supply of the fibrous material and said one end wall is at the opposite end of the drum and the opening therein serves for the removal of the coarse fraction.

11. Apparatus as claimed in Claim 9 or 10, wherein the lifting means is divided into sections which are successively offset relative to one another in the circumferential direction of the drum.

12. A method substantially as

hereinbefore described with reference to the accompanying drawings.

13. Apparatus substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

WHEATLEY & MACKENZIE,
Scottish Life House,
Bridge Street,
Manchester, M3 3DP.
Agents for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1978
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1 525 947 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEET 1

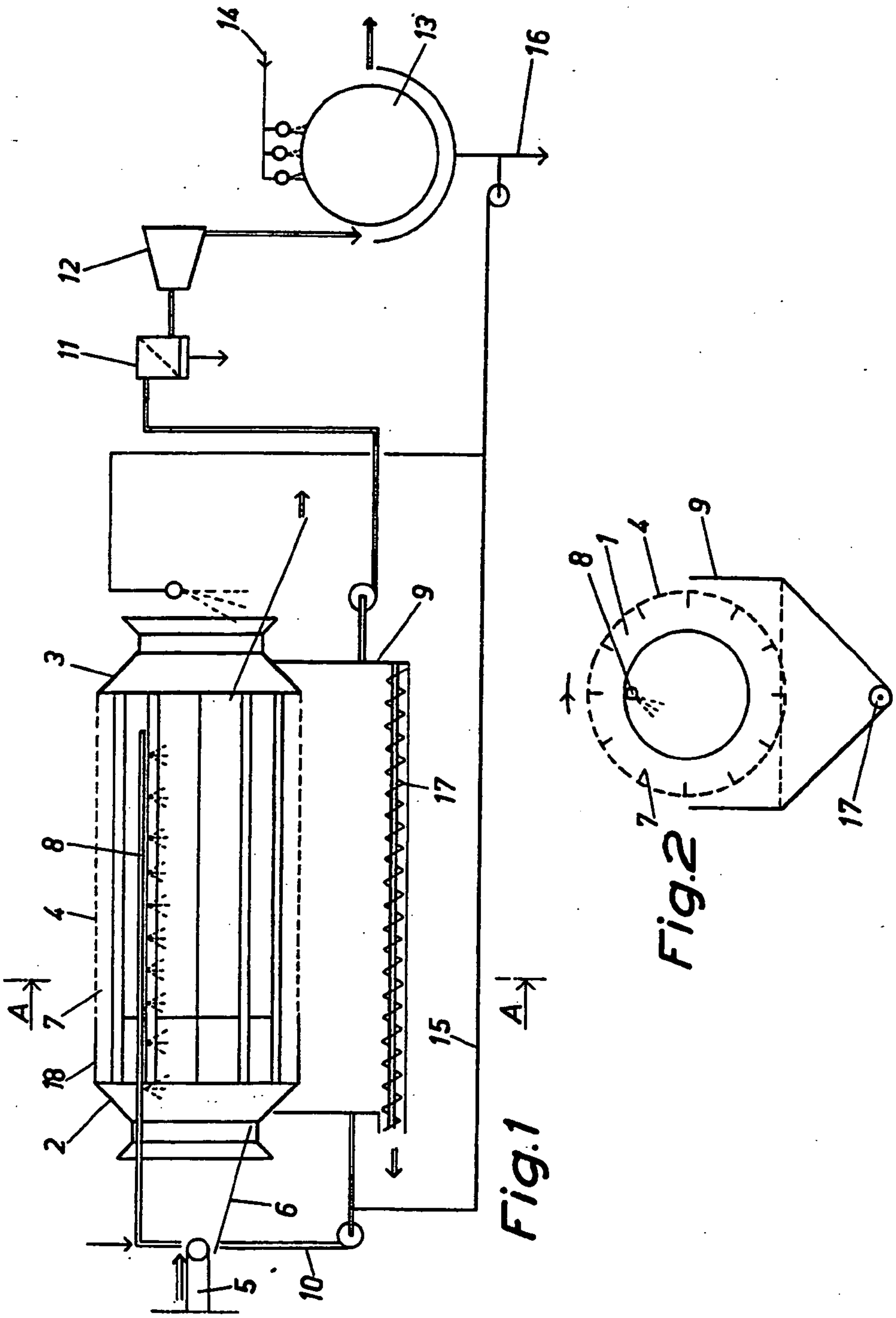

Fig.1

Fig.2

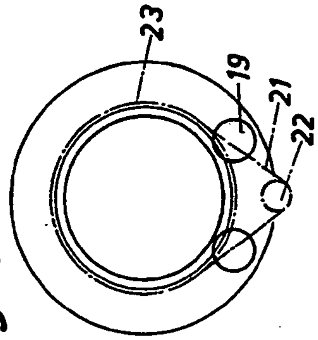

Fig.4

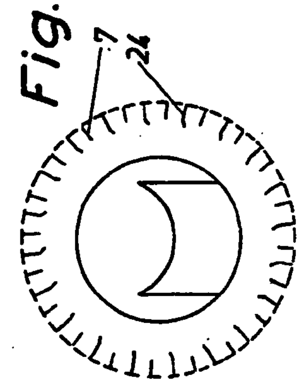

Fig.5

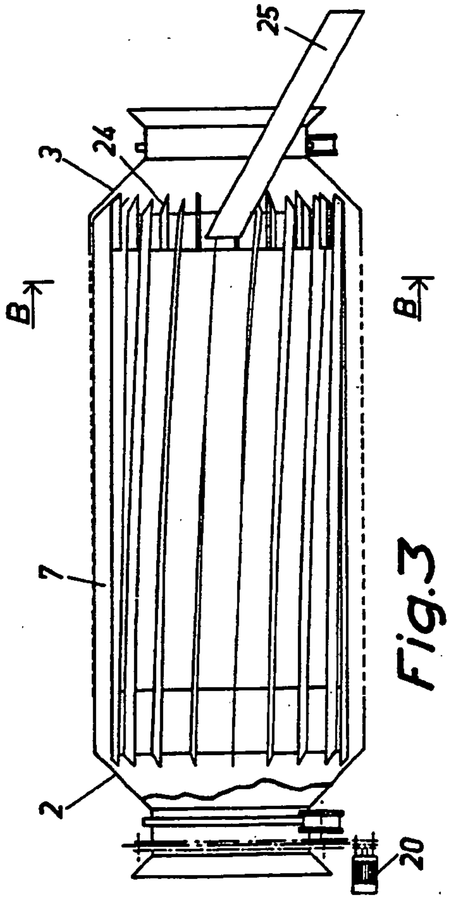

Fig.3